M&N-IT-337

OPTICAL COUPLING SYSTEMS AND OPTICAL CONNECTORS

Cross-Reference to Related Application:

This application is a continuation of copending International Application No. PCT/DE01/03607, filed September 14, 2001, which designated the United States and was not published in English.

Background of the Invention:

Field of the Invention:

The invention relates to an optical coupling system containing at least one optical connector which has at least one optical fiber end piece, a mating coupling element which has a socket for receiving the optical connector, and a shielding plate or conductive housing of the mating coupling element that can be connected in a conducting manner to a metallic structure.

It is known to dispose optoelectronic transceivers for optical data transmission on a printed circuit board. Known in particular are pluggable transceivers of a small type of configuration, known as small form-factor pluggable (SFP) transceivers, which are disposed in a package on a printed circuit board. Other transceivers are fixedly formed in a metallic or metallized housing. The transceivers have in a

way known per se optoelectronic transducers such as a Fabry-Perot laser or VCSEL laser and a photodiode. Coupling infrared light in or out between a transceiver and an optical network takes place via a connector receptacle or more generally an optical port, into which an optical connector can be inserted.

In this case it is customary to dispose the printed circuit board with the optoelectronic transceiver in a metallic housing, for instance the housing of a mainframe computer or server. The housing serves inter alia for shielding against electromagnetic interference radiation, which is produced in particular at high clock rates in the gigahertz range. However, there is the problem that the optical port with the inserted optical connector, or at least a cable connected to the optical connector, has to be led out from the housing. Via the discontinuity or opening in the housing wall (backplane) produced as a result, electromagnetic interference radiation is emitted from the interior of the housing to the outside. The problem increases with increasing clock rates of the transceivers used.

The problem also exists after inserting the optical connector into the socket of the transceiver. This causes instances of electromagnetic overcoupling between conducting parts of the transceiver and conducting parts of the optical connector,

which are at a different potential than the housing. Even when optical connectors which consist exclusively of plastic are used, instances of overcoupling occur, since a plastic connector acts as a kind of dielectric antenna in the case of high data rates and the associated high frequency components in the GHz range, in particular as from 5 GHz. This results in that not even the elimination of metal components from the optical connector offers effective protection against parasitic EMI emissions or electromagnetic interference radiation.

This presents a problem even in the case of other applications and differently constructed transceivers in which optical connectors are coupled to a mating coupling element.

Summary of the Invention:

It is accordingly an object of the invention to provide optical coupling systems and optical connectors that overcome the above-mentioned disadvantages of the prior art devices of this general type, with which electromagnetic interference emissions can be effectively reduced even in the case of high frequencies.

With the foregoing and other objects in view there is provided, in accordance with the invention, an optical coupling system. The system contains at least one optical

connector having at least one optical fiber end piece and at least one component formed of a material for absorbing electromagnetic waves. A mating coupling element is provided and has a socket for receiving the optical connector and a covering being either a shielding plate or a conductive housing. The covering can be connected in a conducting manner to a metallic structure.

It is accordingly envisaged in a first aspect of the invention to form the optical connector of an optical coupling system in such a way that the optical connector has at least one component that is formed of a material that absorbs electromagnetic waves. Use of a material that absorbs electromagnetic rays brings about an improved shielding effect, since electromagnetic radiation is absorbed in the absorbent material, i.e. converted into heat. The absorbent material preferably has for high frequencies of over 5 GHz an attenuation of at least -0.5 dB/cm, preferably of at least -3 dB/cm, particularly preferably of at least -10 dB/cm.

An improved shielding effect by the absorbent material is obtained both insofar as coupled-in electromagnetic interference radiation is reduced (converted into heat) and insofar as a reduced radiation of electromagnetic interference radiation takes place.

Use of an electromagnetically absorbent material has the effect in particular of considerably reducing interference radiation when the optical connector is inserted into a mating coupling element in the region of the discontinuity of a metallic structure through which a socket of the mating coupling element protrudes. There is a shielding and absorptive effect, since electromagnetic interference radiation is conducted and absorbed in the absorber and therefore can only be emitted to the exterior to a reduced extent.

In accordance with an added feature of the invention, the component includes an outer connector housing formed of an absorbent material. In addition, the component may include an anti-kink protector formed of an absorbent material and/or an inner connector housing disposed in the outer connector housing and is formed of a further absorbent material.

In accordance with a further feature of the invention, the optical connector contains no metallic components.

In a second aspect of the invention, an optical coupling system and an optical connector are provided, the optical connector has at least one component that is metallized or formed of an electrically conductive material. In this case, an additional contact device is provided, by which the

metallized components or components consisting of the electrically conductive material can be connected in an electrically conducting manner to a shielding plate or conducting housing of a mating coupling element. The connection may in this case take place directly and indirectly by electrically conducting components of the mating coupling element.

Good, all-round contact with a shielding plate or an electrically conducting housing of the mating coupling element brings about a reduction in radiated interference radiation by allowing the electric potential to be brought to the electric potential of a reference potential, that is the potential of a metallic structure connected to the shielding plate or the conducting housing, on account of the metallization or conductivity of the material. The electric potential of the connector is in this case drawn over the shortest path to the electric potential of the metallic structure, with the consequent effect of reducing the discontinuity, so that there is improved electromagnetic shielding.

In accordance with an additional feature of the invention, the mating coupling element is an optoelectronic transceiver.

In accordance with another feature of the invention, the component has a housing, and the contact device includes contact springs protruding from the housing.

In accordance with another added feature of the invention, the component includes an outer connector housing being metallized or formed of an electrically conductive material.

In accordance with another additional feature of the invention, the component includes an anti-kink protector being metallized or formed of an electrically conductive material. Preferably, the anti-kink protector has a connector-side end being metallized or formed of an electrically conductive material.

In accordance with a concomitant feature of the invention, the component includes an inner connector housing and an outer connector housing surrounding the inner connector housing. The outer connector housing is metallized or formed of an electrically conductive material.

Other features which are considered as characteristic for the invention are set forth in the appended claims.

Although the invention is illustrated and described herein as embodied in optical coupling systems and optical connectors,

it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims.

The construction and method of operation of the invention, however, together with additional objects and advantages thereof will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

Brief Description of the Drawings:

Fig. 1 is a diagrammatic, perspective view of a coupling system with an optical connector and a mating coupling element according to the invention;

Fig. 2 is an exploded, perspective view of a first exemplary embodiment of the optical connector, the optical connector having components made of an absorbent material;

Fig. 3 is an exploded, perspective view of a second exemplary embodiment of the optical connector, the optical connector having metallized components; and

Fig. 4 is a perspective view of a further exemplary embodiment of a mating coupling element, which has a transceiver with a metallic or metallized housing.

Description of the Preferred Embodiments:

Referring now to the figures of the drawing in detail and first, particularly, to Fig. 1 thereof, there is shown schematically two identically formed optical connectors 1, which are respectively fitted at an end of an optical cable 2 and are intended for being inserted into a socket 30 with two connector receptacles 31, 32 of a transceiver 3. The optical connector 1 has a latching element 12 with latching lugs 13 and an actuating lever 14.

The transceiver 3 has in a way known per se a transmitting component (for example a Fabry-Perot laser or a VCSEL laser) and a receiving component (for example a photodiode) (not separately represented), which respectively receive and transmit optical signals via the socket 30 with the connector receptacles 31, 32. Alternatively, the transceiver 3 has only a transmitting component or only a receiving component, and so merely represents a receiving unit or a transmitting unit. In a corresponding way, the socket then only has one connector receptacle.

The transceiver 3 is pushed into a housing 7, which is mounted on a printed circuit board 8 and serves for securing, shielding and contacting the transceiver 3. The housing 7 forms a sheet-metal cage, which usually is formed of a copper alloy or steel alloy and is formed by a lower part 71 connected to the printed circuit board 8 and an upper part 72 mounted on the lower part 71. On account of the metallic form, the housing 7 is a shielding plate 7.

According to Fig. 1, the transceiver 3 is disposed behind a metallic housing wall or backplane 9, which is part of the housing of, for example, a server or other computer. The transceiver 3 is disposed in the backplane 9 in such a way that the optical port 30 of the transceiver 3 protrudes through an opening 91 in the backplane 9, while the optoelectronic components (laser diode, photodiode) are disposed behind the backplane 9. The housing 7 or the shielding plate 7 is in this case coupled to the metallic backplane 9 via contact springs 73. The opening 91 in the backplane represents a discontinuity, via which electromagnetic interference radiation can be coupled out to the outside.

In a further exemplary embodiment of a transceiver, which is schematically represented in Fig. 4, a transceiver 3' has a metallic or metallized housing 7', in which the optoelectronic

transducers of the transceiver 3' are fixedly disposed. The housing 7' is in turn coupled to a metallic backplane via non-illustrated contact elements similar to the contact springs 73 of Fig. 1. Two connector receptacles 31', 32' are provided for respectively receiving a so-called SC connector.

An exemplary embodiment of an optical connector that is merely schematically represented in Fig. 1 is shown by Fig. 2. The optical connector 1, which has the form and configuration of an SC connector and could be inserted into the connector receptacles 31', 32' of the transceiver 3' of Fig. 4, has an outer connector housing 11, an inner connector housing 23, a fiber end piece 24, an adapter 15 and a fiber anti-kink protector 22. The outer connector housing 11 surrounds the inner connector housing 23, which receives the fiber end piece 24. The fiber end piece 24 is usually referred to as a ferrule. In the present exemplary embodiment it is a ceramic ferrule 24, in which an optical fiber is guided in a known way. The adapter 15 receives the unsheathed fiber and passes the inner fiber on to the fiber end piece 24.

The fiber end piece 24 and the adapter 15 are preferably of a metal-free configuration.

It is then envisaged to produce the outer connector housing 11, the inner connector housing 23 and/or the fiber end piece

22 from a material that absorbs high-frequency electromagnetic rays (in particular a frequency of over 1 GHz). In a first configurational variant, materials filled with carbon, in particular a plastic filled with carbon particles, are concerned. In a second configurational variant, a ferritic material is used, in particular a plastic filled with ferrite particles. The base material is in this case preferably plastic, so that plastic filled with carbon or a ferritic material can be produced in a known, simple way by the injection-molding process. Suitable ferritic materials are, for example, obtainable under the designation "C-RAM KRS" and "C-RAM KFE" from the company Cuming Microwave, Aron, MA 02322, USA.

When the optical connector 1 is inserted into the connector receptacle 31', 32' in a way corresponding to Fig. 4 (or when corresponding connectors are inserted into the connector receptacle 31, 32 according to Fig. 1), the connector receptacle is shielded, so that, in spite of the opening 91 in the backplane 9, electromagnetic interference radiation is radiated only to a reduced extent. Consequently, the use of absorptive materials has the effect of considerably reducing the radiation of electromagnetic interference radiation to the exterior.

Fig. 3 shows an alternative exemplary embodiment of the optical connector. The optical connector in turn contains an outer connector housing 11', an inner connector housing 23', a fiber end piece 24', an adapter 15' and a fiber anti-kink protector 22'. In the case of this exemplary embodiment, the outer connector housing 11', the inner connector housing 23' and/or the fiber anti-protector 22' are metallized or they are formed of an electrically conductive material.

In the case of metallization, the coating is applied to the outer skin of the respective component, for example by an electrodepositing process or vacuum metallization. It is also conceivable to enclose the component 11', 22', 23' formed of plastic with a wire mesh or with a plastic containing conducting filling particles. For example, a flexible EMI gasket may be disposed on two sides of the connector housing 11'.

For the case in which the components 11', 22', 23' are formed of an electrically conductive material, it may be provided on the one hand that they are formed of metal. Alternatively, non-conducting materials may be used, which are provided with conducting filling particles, for example silver-enclosed beads, and are conductive on account of these additional components.

Provided on the connector housing 11' are two contact springs 111', 112', which, when the optical connector is inserted into a socket of a mating coupling element, contact correspondingly metallized components of the mating coupling element or of a metallic or metallized housing or shielding plate of the mating coupling element. For example, the contact springs 111', 112' contact the metallic housing 7' of the exemplary embodiment of Fig. 4.

As an alternative to the contact springs 111', 112', EMI gaskets which are formed of a foam filled with conductive particles or a wire mesh may also be provided on two or more sides of the housing.

The inner connector housing 23' has a lug 131', which latches with latching hooks of the mating coupling element during the latching engagement of the connector in the socket of a mating coupling element. The lug 131' of the inner connector housing 23' is in this case likewise of a metallized or electrically conducting configuration. In the case of metallized latching hooks of the mating coupling element, a further electrical contact with a shielding element of the mating coupling element is established by the metallization of the inner connector housing 23'.

The anti-kink protective sleeve 22' has on the sides facing the optical connector a cuboidal portion 121'. The latter is seated in a sliding manner in the connector housing 11' when the optical connector is in the assembled state. It is provided that the cuboidal region 121' in particular is metallized, so that surface-area electrical contact is provided on the sliding surface. This may be provided in this case either by the sliding surface 121 itself or by additional non-illustrated contact springs, which are formed on the cuboidal portion 121'.

When the optical connector 1 is inserted into a socket, a difference in potential is prevented on account of the contacting between the metallic optical connector and the shielding element or housing 7' (see Fig. 4) and the further contacting of the shielding element or housing with a metallic structure; it is consequently prevented that the connector acts as an antenna and couples electromagnetic interference radiation out to the outside.

The invention is not restricted in its implementation to the exemplary embodiments represented above. For example, a combination of metallized and absorptive materials may also be used in the connector. For example, in this case the outer connector housing is metallized, while the fiber anti-kink protector is formed of an absorptive material. Furthermore,

it is pointed out that the optical connectors described in Fig. 2 and 3 are to be understood only as being given by way of example and not as restrictive. The invention can be used on any desired optical connectors.